Propionyl-series. *Succinyl-series.*

Propionic acid. . $C_2(C_4H_5)\left.\begin{matrix}O_2\\H\end{matrix}\right\}O_2$ Succinic acid. . $C_4(C_4H_4)O_4\left\{\begin{matrix}H\\H\end{matrix}\right\}O_2$

Anhydrous propionic acid. $\left.\begin{matrix}C_2(C_4H_5)O_2\\C_2(C_4H_5)O_2\end{matrix}\right\}O_2$ Anhydrous succinic acid. $C_4(C_4H_4)O_4,O_2$

Propionylamide $N\left\{\begin{matrix}H\\H\\C_2(C_4H_5)O_2\end{matrix}\right.$ Succinamide. $\left.\begin{matrix}N\\N\end{matrix}\right\}\begin{matrix}H\\H\\C_4(C_4H_4)O_4\\H\\H\end{matrix}$

VII. "Description of an Instrument for registering Changes of Temperature." By BALFOUR STEWART, Esq. Communicated by J. P. GASSIOT, Esq., F.R.S., Chairman of the Kew Observatory Committee of the British Association. Received June 12, 1856.

It lately occurred to the author that advantage might be taken of the capillary action of mercury to construct an instrument similar to a thermometer, but in which the mercury should expand from heat only in one tube, and contract from cold only in another. Accordingly a bulb was blown between two thermometric tubes of differently-sized bores, in such a manner that the tubes lay in one straight line, with the bulb between them. The bulb was then filled with mercury, and the tubes were hermetically sealed at both ends, having been first carefully deprived of air. When the instrument thus constructed was laid in a horizontal position, or nearly so, its action was precisely what the author had hoped; the mercury contracting from cold only in the narrow bore, and expanding from heat only in the wide one,—even when viewed by a microscope of considerable magnifying power.

It was suggested by Mr. Welsh, Director of the Kew Observatory, that such an instrument might be used for measuring fluctuations of atmospheric temperature; and the following use afterwards occurred to the author. Were it required to exactly estimate the radiating

effect of a source of heat, it might perhaps be done by placing this instrument near the source, alternately exposing it to the influence of the calorific rays proceeding from the source, and intercepting these by means of a screen. Owing to the peculiar action of the mercury alluded to, the effect of the rays would be multiplied by the number of times the screen was interposed, provided it were always retained long enough to permit the mercury to cool down. The comparison of an instrument thus acted upon with another similar instrument near it, screened entirely from the source of heat, might furnish us with a means of exactly estimating the heating effect of the source.

The author desires to express his obligation to Mr. Welsh, who, besides finding a use for the instrument, suggested the selection of tubes which appears to answer best, and whose experience was of great assistance in arranging details. He is also indebted to the Kew Committee of the British Association, who kindly examined the instrument, and authorized the construction of several by way of trial. Mr. Casella undertook the operative part in their construction, and his glass-blower, Mr. J. E. Griffin, took pains to discover some of the circumstances that interfere with the proper action of the instrument, and constructed those that have proved successful.

Without attempting to explain all the peculiarities of this action, it would seem that the mercury is kept in the narrow bore, and prevented from retreating into the bulb, by friction; but, when a moving force is supplied by means of a change of temperature, the motion of the mercury takes place in that direction in which it is least opposed, or most aided, by its capillary action.

As the result obtained is due to the difference between two forces, neither of which is very great, the construction of such an instrument requires care; and the author will now state what appear to be the chief points which demand attention, as derived from his own experience, and that of those who have interested themselves in the construction of the tubes; although this experience is necessarily very limited.

1st. The tubes should be quite clean and free from moisture.

2nd. They should be in one straight line, and should expand symmetrically into the bulb.

3rd. It seems the best arrangement, to have the narrow tube of flat bore, not too flat; its greatest width being about equal to the

diameter of the wide bore, which should be cylindrical, and neither conical nor flat.

4th. The tubes should be well deprived of air before being sealed. The instrument may be thus graduated.

If, when held vertically, the smaller tube being below, the mercury at the ordinary temperature should fill the lower tube, the bulb and part of the upper tube, the instrument may be pointed off in the same manner as an ordinary thermometer. But, if the mercury under these circumstances be not enough to fill the bulb, the best plan is perhaps to lay the instrument horizontally in a vessel of water, side by side with a standard thermometer, and, keeping the extremity of the mercury in the one tube at a constant point, to mark off its extremity in the other tube at two or more different temperatures, as shown by the standard thermometer. The length of this tube corresponding to a degree may be then found in the usual way.

The same process may be followed with the other tube. Or, take two points in the first tube—say A and B, the distance between them being, say 50°. Set the mercury at the point A, and mark off its other extremity in the second tube. Set it now at the point B, and mark its extremity in the second tube. The distance between these two points in the second tube will be the length corresponding to 50°.

Graduate the tubes to within a short distance of the bulb, and the best plan is perhaps to number the degrees from one extremity of the instrument, beginning 0...10...20, &c., on to the mark on that side nearest the bulb. Suppose this mark is numbered 100°; then number the mark nearest the bulb on the other side also 100°, and go on upwards numbering 110°, 120°, 130°, &c., until reaching the other extremity of the instrument. In the next place ascertain the temperature of the mercury when it fills the bulb and reaches only to the nearest mark on both sides.

Let this be C°. In taking an observation, note the numbers at both extremities of the mercury, and deduct the less from the greater. To the *positive* remainder add the constant C *with its proper sign*, and the sum will give the true temperature.